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WOOL

AND

WOOL MANUFACTURE

A BRIEF ANALYSIS
FOR THE LAYMAN

THIRD PRINTING

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OF BOSTON

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WOOL

AND

WOOL MANUFACTURE

A BRIEF ANALYSIS FOR THE LAYMAN

BY

JAMES PAUL WARBURG

of The First National Bank of Boston,
who gratefully acknowledges the invaluable collaboration of his colleague, H. B. Kingman, and the kind assistance rendered by various customers and friends of the bank

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INTRODUCTION

Wool is one of the world's primary raw materials. The United States grows only about one-half of the wool it consumes, and *seventy per cent.* of the wool imported from other countries comes through the port of Boston. Of this seventy per cent. about one-half is financed by The First National Bank of Boston.

It is the purpose of this paper briefly to tell the story of wool and wool manufacture; to outline, in other words, the various stages intervening between the back of the sheep and the back of the man who wears the finished product. We shall not go very deeply into the technical side of the various manufacturing processes, but we shall attempt to sketch their functions and point out their interrelations. Finally, we shall endeavor to throw some light upon the financing of the separate stages.

The discussion of this rather large subject falls naturally into four parts: First, the raw material; second, worsted manufacture; third, woolen manufacture; and fourth, the financial side of the question.

Parts 1, 2, and 3 will take us, in rather a hasty survey, from the birth of the lamb as far as the finished cloth. We have omitted the cutting up and tailoring processes because they do not in any way alter the material. Part four will attempt to show who furnishes the money and who makes the profit in each stage.

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It will perhaps be well to call the reader's attention at the outset to the fact that wool manufacture includes two entirely distinct industries, the worsted and the woolen, and that from the very start, clothing wools are headed for the woolen industry, while combing wools are destined for the manufacture of worsteds.

This paper is based in part upon actual observation, in part upon standard works on these subjects. If liberal use has been made of the latter it is due to the fact that this does not pretend to be an entirely original treatise, but rather a condensation of existing materials for the benefit of those who are interested in the various stages of the industries, from an outside point of view.

Boston, Mass.,
April 19, 1920.

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PART ONE
THE RAW MATERIAL

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CHAPTER I

Sheep Raising

The raising of sheep goes so far back into primitive times that historians have been compelled to draw a veil over its origin. Whether sheep ante-date man, or man existed before sheep, is a question that has never been authoritatively answered. For our purposes very little history will suffice. We know that sheep were raised in Biblical times, but we do not know much about them. We do know, however, that the old Romans practised sheep-breeding with great care and even went so far as to cover their animals with cloth in order to preserve the clean quality of the fleece. During the reign of the Roman Emperor, Claudius (A. D., 50), an Italian named Columella, took several Italian sheep to Spain and crossed them with the native Spanish Merino breed. It is said that the resulting type is the progenitor of all the Merino breeds which now form the basis of sheep-breeding. Under the rule of the Saracens, Spain became not only a great sheep-raising country, but a woolen manufacturing country as well. In the thirteenth century there were no less than sixteen thousand looms in the town of Seville alone.

Early History

When the Saracens were driven out by Philip III. the textile industry disappeared from Spain, but sheep husbandry, which did not require skilled labor, remained, and Spanish wool continued to be the finest in the world.

Spain

During the eighteenth century various European countries began to import merinos and cross them with their native breeds. This, because of the sturdy quality of some of the native types, frequently produced excellent results. In France we thus have the origin of the Rambouillet merino, in Germany and Austria of the Saxony and Silesian breeds. In 1810 merinos were first introduced into Australia with astonishing results both as to grade of wool and increase of flocks. About the same time South America, South Africa, and the United States imported Spanish sheep. Of all the highly civilized countries, England is the only one where merino breeding was not successful. This was due in part to the climate, but the chief cause was the fact that British sheep-raising was primarily for mutton purposes, and only secondarily for wool. The merino types are smaller, and hence do not yield as good mutton carcasses as some of the native "Down" and "Mountain" breeds. In many cases, however, the native English breeds, notably the Lincolns, have been imported to other countries and there crossed with merinos with very good success.

Europe

Spread of Merino

It would not be possible to give in detail the various breeds of sheep existing in different countries. Merino sheep are now bred in many parts of the world, and, together with the high crossbreds, are the source

Native Breeds

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of all the fine wools known as merino, half-blood, and three-eighths wools. Long wools are derived from various native breeds, chiefly English, and from the lower crossbreds of merinos, such as quarter and low quarter bloods. Chinese, Siberian, and Turkish wools, as well as many other uncivilized types, are usually very long and coarse, and are known as carpet and braid wools.

Sources

Most of the best merino wools come from Australia, the next from South Africa, and then those from South America. The latter have one fault in that they contain many spiral burrs which are difficult to remove, and which frequently get through the machines and show up as imperfections in the cloth. Europe grows some very fine short wools, but these hardly ever leave the countries they are grown in.

U. S. Domestic

United States wools are known as domestic and territory. Domestic wools are those grown in the eastern and middle western states, notably in the Ohio valley. These contain the highest grades of merino wools grown in this country. It must be remembered that sheep raising began in the East, and as civilization expanded, was gradually crowded further and further westward. The opening of the Erie Canal in 1825 made available the fertile pasture lands of the Ohio valley. The Ohio Canal eight years later opened up still more territory, and in 1849 during the famous gold rush, sheep were first taken to California.

Territory

The territory wools are those grown in the Rocky Mountain Plateau states. Recently, with improved methods and greater care in breeding, some very fine wools have been derived from Idaho, Wyoming, Nevada, and Montana, and from a few other states. The Texas and California wools are usually classed separately, because they are in most cases clipped twice a year. In chapter four we shall discuss the various grades and sorts of wool obtained from the different breeds, but as the wool is shorn or pulled before it is graded, we shall take up these processes first.

AVERAGE WEIGHTS OF DIFFERENT BREEDS OF SHEEP WITH WEIGHTS OF FLEECES

Breed	Ewes Pounds	Rams Pounds	Fleece Pounds	
Leicester	185	235	10	
Cotswold	200	285	12	
Lincoln	250	300	15	
Southdown	145	200	6	English Breeds (Mutton)
Shropshire	165	215	9	
Oxford	220	275	11	
Hampshire	200	275	8	
Rambouillet Mer.	155	235	18	
Amer. Merino A.	105	145	22	
" " B.	110	155	20	Merino Breeds
" " C. (delaine)	125	175	18	

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CHAPTER II

Shearing and Marketing of Fleece Wool

Wool is obtained from the sheep in two ways; it is either shorn from the live animal, or pulled from the skin of the slaughtered carcass.

Shearing

Shearing was formerly done by hand. An expert was able to clip as many as one hundred head per day, but the average was less than half of that amount. The introduction of machine shearing has made it possible for one man to shear from 175 to 200 sheep in a day, and the fleece is very much more evenly clipped than formerly. Some merino breeds, known as type A., have so many folds of loose skin that machine shearing is not feasible, but except for these animals, and some of type B. or Rambouillet Merinos, almost all sheep are now shorn by machine, that is, where they are raised in numbers. Sheep raising in this country is not pursued with nearly so much care as, for instance, in Australia. There they have huge shearing sheds where the animals are first sweated and then carefully shorn. The belly is shorn separately, whereas here the entire fleece is left in one piece. In Australia each fleece is carefully skirted, that is, the inferior parts such as the britch are torn off. Then each fleece is folded and tied up and the fleeces are put up in bales. Moreover, a bale usually contains fleeces of the same grade, so that practically nothing but sorting remains to be done by the purchaser. Here, on the other hand, fleeces are shorn in one piece and are folded up carelessly, without skirting. The tying up is frequently done in a slovenly manner, and a bag will very often contain all grades of wool from the finest to the coarsest. Of late years some attempt has been made to install the Australian system, but without much success.

Australian System

Seasons

The shearing season in the northern hemisphere is in the spring, in countries below the equator, except Australia, it is, of course, in our fall. In Texas and California, as well as in some other localities, shearing is frequently done twice a year.

Marketing

Roughly speaking, there are seven ways in which the wool grower may dispose of his fleece wool:

Merchant Buyers

1. He may sell it to buyers representing merchants. The merchant, while he is a middle man and therefore incurs the usual anathema, performs a variety of very essential services. At the time of the clip he sends his buyers to the wool producing centers and buys the clip for cash, then he ships it to his warehouse, grades it, and sells to the mills on credit. Obviously he finances a very important part of the production, and is furthermore essential, because he knows the demand, which the wool-grower does not, and the supply—of which the mill is usually ignorant.

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Mill Buyers

2. The wool grower may also sell to buyers representing mills. He likes to do this because he eliminates the merchant's profit, but, as a matter of fact, there are only very few mills large enough to stand the buying expense, and even fewer that can afford to buy their whole season's supply of raw material at one time and for cash. Also, mills can usually employ only certain grades.

Consignment

3. If the grower thinks that he is not receiving fair offers from the visiting buyers, he will frequently consign his wool to a merchant to be sold on commission for his account. In this case he may or may not get a better price, but it costs him his carrying charges plus commission. There are some wool houses that make it a specialty to execute commission sales of this nature.

Local Mills

4. Some wool is sold direct to nearby mills. This is done particularly in Ohio, where many of the smaller mills obtain their entire requirements in this manner.

Local Dealers

5. Wool growers sometimes sell to local dealers. This is particularly prevalent in regions where the individual grower's production is small. In most eastern states there are a great number of small farmers who grow a certain amount of wool. The local dealers are in many cases also the general store-keepers, and, since they are the farmer's creditor on other merchandise, and since the average farmer knows very little about the grades of wool, these individuals very frequently turn a handsome profit when they in turn sell to the visiting buyers.

Coop. Sales

6. Some wool is sold through farmers' co-operative sales agencies. But these organizations have in the past been so poorly administered, that, as a general rule they have not been successful.

Auctions

7. Finally, there remains the method whereby almost all the British and colonial wools are sold, namely, by auction. Auction sales have been established for almost a century in London, Liverpool, Antwerp, Bremen, Hamburg, Marseilles, and recently in Australia. This method of disposing of their raw product does not, however, appeal to the American growers, because of the inherent American trading instinct. It is also not very feasible in this country, because the wool is not graded in the shearing sheds and because sheep-raising is not standardized.

Markets

The chief markets for wool in this country are Boston, Philadelphia, Chicago, New York and St. Louis.

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CHAPTER III

Pulled Wool

We have above discussed the shearing and marketing of wool obtained from the living animal. There remains a large quantity of wool which is taken from the pelts of slaughtered sheep. In 1919 there were produced 48,300,000 pounds of pulled wool in the U. S. as against 265,939,000 pounds of sheared wool.

Use

Skin wool, or tanner's wool, as it is sometimes known, is used extensively for soft twist yarns, bed blankets, flannels, felts, etc. It is also used as an admixture in blends for top-making, as we shall see later.

There are three methods whereby pulled wool is obtained.

Sweating

The oldest and simplest process is known as sweating, and consists simply in sweating the hides until the wool is loosened and can easily be pulled out. The disadvantage of this method is that it injures the hides.

Lime

The lime process consists in loosening the wool by painting the flesh side of the hide with lime. This also injures the hides somewhat and has a bad effect on the dyeing qualities of the wool.

Depilatory

The depilatory process is the best, and varies from the lime process only in that a solution is used instead of lime. This mixture consists of sodium sulphate, sulphuric acid, and oyster shells.

By far the greatest pullery in the world is situated at Mazamet, France, where the industry has assumed gigantic proportions. The large packers in this country all operate their own pulleries, and the pulled wool is marketed largely by them. Most mills buy their pulled wool direct from the pulleries, but some is handled by merchants.

CHAPTER IV

What is Wool

The Wool Fibre

We have now traced the wool from the sheep's back as far as the bag, and we may assume that the bag has travelled from the shearing shed to the merchant's or mill's warehouse. Some foreign wools, notably Australian and South American, are, as we have seen, skirted and roughly graded in the shearing shed, so that, when the bag is opened, there remains only the sorting to do. Grading is the separation of fleeces into classified groups. Skirting is the removal from each fleece of the worst parts, namely, the britch wool, manure locks (known as tags), and matted or kempy portions. Sorting is the dividing of the individual fleece into various classifications.

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Before we take up the grades and sorts in detail, it will be well for us to inquire briefly into the nature of the wool fibre. In the first place, wool differs from hair in that its fibre consists of a core (medulla), a pulp (cortex), and an epidermis. A hair follicle consists of a medulla and an epidermis. Moreover, the epidermis of a hair is closely and evenly scaled, which makes it smooth and lustrous. The surface of a wool fibre is not evenly serrated, which accounts for the felting, or interlocking, quality. Wool in which there is insufficient moisture and natural grease (yolk) frequently becomes felted at the ends. Such wool is variously referred to as cotted, cotty, or brashy. The tensile strength of a wool fibre is low, its elasticity high. The length of the fibre varies from one to over ten inches, and the diameter from .0018 to .004 inches. The better a wool the less like it is to a hair. Generally speaking, the finer the wool, the shorter the fibre, but length alone would not indicate the grade. Pure merino and high cross-bred wools have a close wave, known as crimp, which increases the elasticity and is therefore desirable from a spinning standpoint.

Wool as Against Hair

The chemical composition of wool is: carbon 50%, hydrogen 7%, nitrogen 18%, oxygen 22%, and sulphur 3%. It is soluble in alkalies, and at a temperature of 130° C. will reduce to powder.

Wool before it is scoured contains a large quantity of yolk, or natural grease, and also, besides dust and vegetable matter, a considerable amount of dried perspiration, or suint. The amount of weight lost through the removal of these substances when the wool is scoured is termed shrinkage. It will be readily appreciated that this is a very important factor in connection with the purchase of grease wool. The percentage of shrinkage varies from 20% to 80%. Nevertheless a good buyer will often be able to estimate within one or two per cent. The factors to be considered in this connection are the breed, the soil, the climate, and the care with which the sheep are raised, as well as the diligence with which the fleeces are put up. Fine wools always shrink more heavily than coarse; and pulled wools, since they are washed and brushed during the process, show a very much lower shrinkage than fleece wools. The average shrinking of United States wools is about 55%. Fine domestics shrink about 60%. Lower grades about 45%. Fine territory wools about 65%; lower grades about 55%. Pulled wool averages about 27%. Fine Australian wools average 49%, for, although they are the finest, the fleeces contain less dirt. Cape wools about 62%, and South American about 51%.

Shrinkage

Qualities Desired

The qualities looked for in wool are roughly six, and they vary according to the purpose for which wool is to be used.

1. It must be fine enough to spin the required number of counts.
2. It must be strong enough to withstand strain of manufacture.

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Grading fleeces

3. It must have the proper staple (length).
4. It must be of a certain softness or hardness.
5. It must have the proper felting qualities if the material is to be fulled.
6. It must either scour white, or else have sufficient lustre to take dyes.

Clothing and Combing

As we take up the manufacture of worsted and woolen yarns we shall see how these qualifications play a different part in the two processes. For the present the only difference we are concerned with is staple length. Generally speaking, wools under two inches are too short to be combed and are classed as clothing wools. Clothing wools are used for woolens, combing wools for worsteds.*

In grading and sorting, practically the only guide is the fineness of the individual fibre. The other qualifications just enumerated have a very imporant bearing on what the wool can be used for, but they have very little to do with its classification by grades.

*In recent years combing machinery has been devised which will comb wools under one inch in length so that a considerable quantity of "clothing wools" now go into worsteds.

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Sorting Wool

Classifications

Fleece wools are graded by two systems, one by bloods, the other by counts spun. (This means the number of hanks of 560 yards each to a pound of yarn.) Domestic and foreign wools are usually graded by bloods. U. S. Territory wools are graded a little differently, as per second column below, and pulled wool is only roughly graded into four classes (third column). The blood classifications originated from the breeding of the sheep, but, as a matter of fact they have become arbitrary terms denoting a certain degree of fineness. The same fleece may, and frequently does, contain ½, ⅜, and ¼ blood wool.

COMPARATIVE GRADES

U. S. Domestic	U. S. Territory	Pulled	U. S. Counts Spun	Foreign Counts.
Full blood (XX)	Fine	AA	60s	66-74s
¾ " (X)	¾		50s	60-66s
½ "	½	A	40s	54-60s
⅜ "	⅜	B	36s	48-54s
¼ "	¼	B	32s	44-48s
Low ¼	Low ¼	C	20s	40-44s
Common	Common	C	16s	36-40s
Braid	Braid	C	12s	32-36s

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When a bag of domestic wool is opened the fleeces are taken out one by one and put into baskets according to the grades in the first column. The grader simply decides what the majority of the fleece is and puts it into that class. When he has filled a basket with, let us say, half-blood fleeces, this basket is given to a sorter. He takes each fleece, shakes it out, and, first of all, skirts it. Then he separates it into the various sorts it contains. Fleeces graded as half-blood will probably sort into mostly half, some fine (full-blood), and a considerable quantity of three-eighths blood. The best wool comes off the shoulders, then the sides, then the back, then the thighs, and finally the britch and belly. Usually a fleece will not contain more than three sorts.

Grading

Skirting

Sorting

If this were a bag of Australian, South American, or Cape wool, the fleeces would in all probability have been bagged according to grades, so that only the sorting operation would have to be performed by the merchant or the mill.

When the wool has been sorted it is put into bins, and may now be said to be ready for the first of the manufacturing processes for which it is destined. Sorting is sometimes done by the merchants, but more frequently by the manufacturers.

Kempy or cotted pieces, tags, stained or painty wool, etc., are called off-sorts, and these are put through a number of processes for the purpose of reclaiming as much of the wool as possible.

Off-sorts

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PART TWO
WORSTED MANUFACTURE

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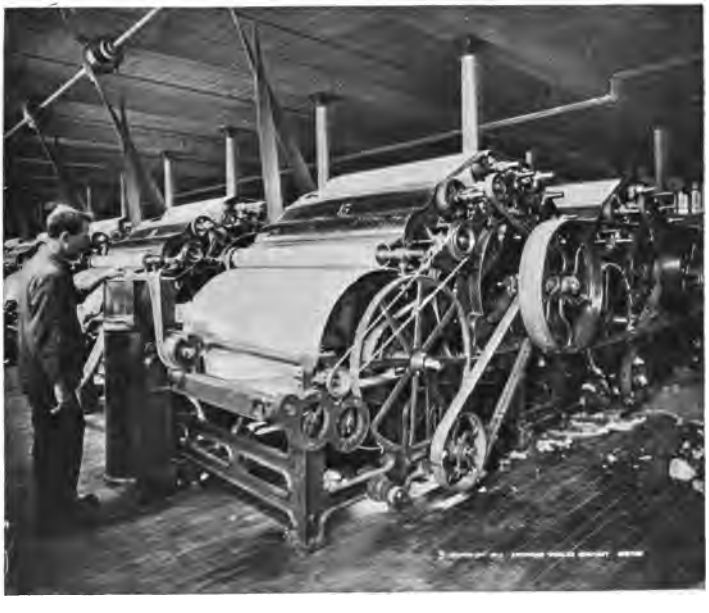
Scouring Machine



Worsted carding Machine

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CHAPTER V

Scouring

When the wool has been graded it is sold either to worsted manufacturers or to makers of woolen goods. The two industries are entirely distinct and separate.

The first cog in the worsted machine is the wool comber, or top-maker. Sometimes he buys assorted grades, known as matchings, from a wool merchant; sometimes he buys and sorts his own wool; but most frequently he sorts and combs the wool on a commission basis. Many of the big worsted mills do their own sorting and combing. *Blending*

Tops are usually made from blends of various kinds of wool, and this blending is done after sorting, before the wool is scoured.

Scouring is nothing more or less than a glorified washing. A machine closely akin to a gigantic laundry machine removes first the yolk or grease in an alkaline solution, and then rinses out the dirt and suint in a series of soap and water baths. The last bath is pure water, and from this the wool is taken on a belt through the drier. From the drier it is usually blown through tubes to the carding room. *Scouring*

Approximately 20% of the moisture is allowed to remain in the wool in order to facilitate subsequent processes. If the wool is still warm it is easier to card.

CHAPTER VI

Carding

The purpose of the carding operation is to open out the fibres in the wool. Originally, carding was done by hand with two leather surfaces, much like butter pats, the inner faces of which were studded with wire nails. Between these two surfaces the wool was rubbed until all the fibres were opened out. In woolen manufacture carding is more violent and seeks to lay the fibres in all directions. Worsted carding aims to separate the fibres, but also to keep them as closely parallel as possible. *Opens Fibres*

The carding machine is a very complicated piece of mechanism, which we can only attempt to describe here in a cursory manner. The wool is automatically fed between the feed rollers, which revolve in opposite directions and are armed with heavy teeth. From the feed a roller known as the licker-in starts the wool on its course over a number of cylinders, each of which is surrounded by several toothed rollers known as workers. Each worker has a smaller companion roller, revolving at a higher speed, which derives its name of stripper from the fact that its function is to take the wool off the worker and deliver it to the next *The Card*

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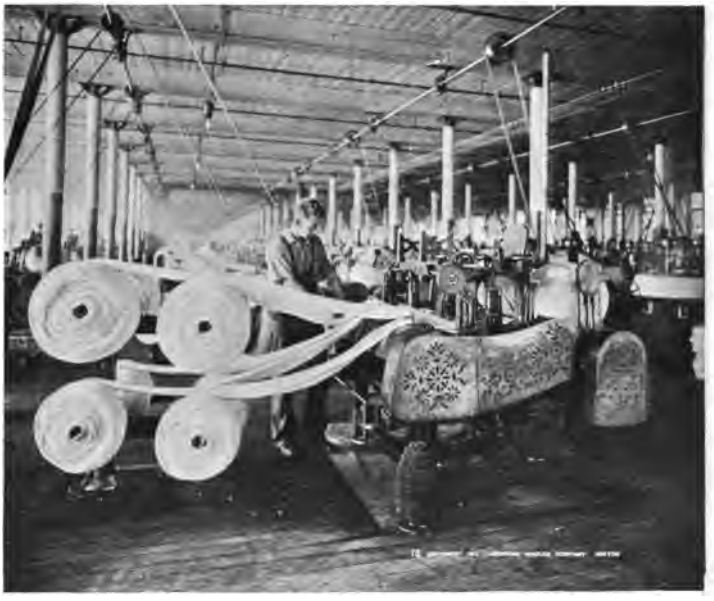
Back washing



Gilling before combing

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worker. The last roller, known as the fancy, raises the wool off the cylinder to be caught by the doffer. The doffing-comb lifts the wool in a filmy sheet of fibres, which is condensed into a thick untwisted rope by passing through a funnel on to the balling-head. This rope, which is about an inch and a half in diameter, is known as a sliver. A certain length of it is automatically rolled into balls and these are taken into the back-wash room. From a loose unrelated mass the wool has now been transformed into a continuous strand of more or less uniform diameter.

CHAPTER VII

Backwashing and Gilling

A back-wash machine takes several of the carded slivers and combines them into one. The slivers pass through several baths which rinse them thoroughly and are then slowly drawn through a drier. The process is quite similar to scouring, except that it is very much less violent.

As the slivers come out of the drier they are fed through a number of gill boxes. The gill box is the first of a long series of drawing operations. In this, and all the following stages of open drawing, there are always several slivers being combined into one and drawn out until the resulting sliver has about the same or a smaller diameter than the ones fed into the machine. The principle of the gill box is quite simple. Several slivers are fed in between rollers revolving at a comparatively low rate of speed. As they pass through they are flattened out over what is known as a faller. This is armed with very fine close wire teeth which come up through the fibres and the draft is imparted when the wool is taken off the faller by a final pair of rollers which are revolving considerably faster. The sheet of wool which emerges from these rollers is again passed through a funnel and thereby condensed once more into a sliver. This operation is repeated from two to four times, according to the quality of the top desired, and the methods employed by the particular mill.

Combining and Drawing Slivers

Where very coarse long fibred wool is to be worked there is no carding, and the wool is prepared by straightening the fibres into a sliver through a series of gill-boxes.

At some point during the gilling process a slight amount of oil is usually dropped onto the sliver, as this facilitates combing.

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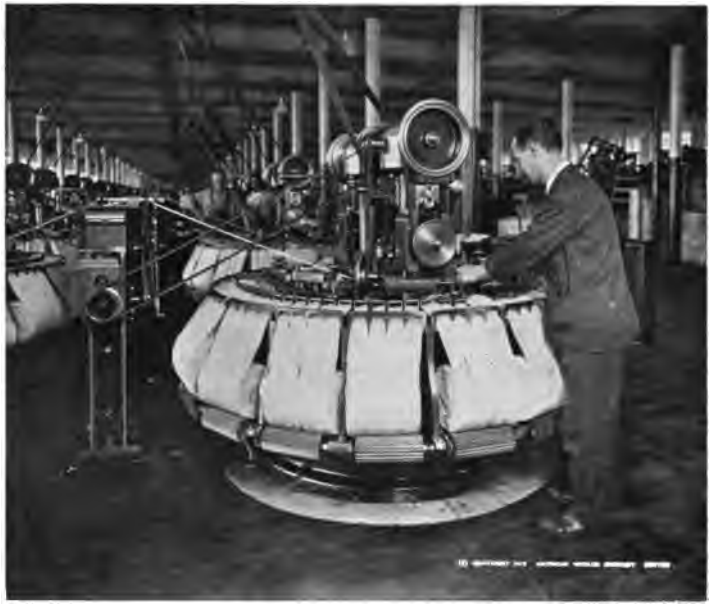

The Noble Comb

CHAPTER VIII

Combing

Removes Short Fibres

The next operation, namely that of combing, is again simple when viewed as the primitive manufacturing stage. The old comber would take a short length of sliver, hang it on a nail by tying one end together and then proceed to comb out the short fibres much as one may comb out the dead short hairs from a dog's coat. Combing is simply the removal from the sliver of the short fibres which would not spin properly. These short fibres are known as noils and are the waste product of top-making. The top is a continuous untwisted strand of long wool fibres made parallel by the comb. (By long fibres we mean fibres which are relatively long. Some tops consist of fibres less than an inch and a half in length. In this case, which is very infrequent, the noil would be even shorter.)

Noils

Noils are sold either to woolen or knitting mills direct by the top-maker, or else sold to a merchant who disposes of them.

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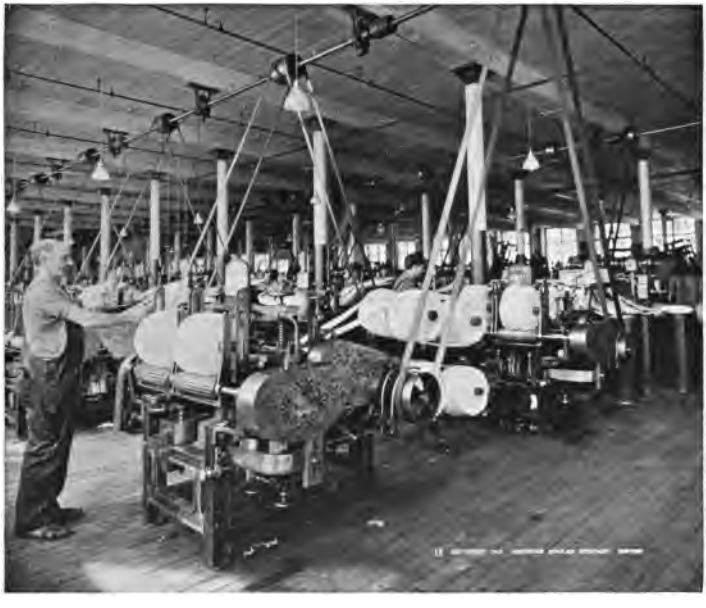
The Noble Comb

The Noble circular comb is the most generally used combing machine. Other types are the Lister, the Holden, and the Heilmann. The Noble comb is a compact circular structure standing at a height of about three feet from the floor, with a steam box underneath it. (Heat greatly facilitates the process.) There are two smaller circles inside the main circumference which are tangent to the outer circle at opposite points of its diameter. All rotate in the same direction. Seventy-two slivers are rolled up in creels on the outside of the main circle and are automatically fed on to the tangental points. A dabbing brush pushes the slivers down between the points of the two circles. As the circles draw apart the long fibres are left protruding from the inner edge of the outer circle and the outer edge of the inner circles. They travel thus until they are gripped by vertical rollers set to catch them. After passing the rollers the wool is lifted off the pins of the circles by knives. The four ribbons of combed fibres (two from the outer and one from each of the inner circles) are condensed into a single beautiful even band which coils itself softly into a revolving can. What remains is the waste or noil.



Gilling the top

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Gilling the Top

The top, as it comes from the comb, is again put through a series of several gill boxes with the object of further drawing it out. Once again several slivers are combined into one in each process. At the end of this gilling the top is coiled in balls and allowed to rest.

We have now reduced the wool to its real worsted basis. The noils have been taken out, and the balls of top are ready to be sent to the spinner to be spun into worsted yarn.

CHAPTER IX

Spinning

The first processes in a spinning mill very closely approximate the last operations in the combing plant. The tops are usually gilled several times before weighing, and then are put through several drawing machines in which, as heretofore, several slivers are condensed into one.

Drawing

In the last of these machines there are no fallers, the entire process consisting of two sets of rollers revolving at different speed. Each operation results in a slightly finer sliver, and the number of machines through which the material is drawn is determined by the fineness of the yarn desired.

The last of the drawing processes is the so-called roving box, which, in most cases is a cone-drawing process. There is a difference here between French spinning and English spinning. According to the French

French

system, which is employed in this country only for very soft fine yarns, no twist is given to the sliver until the actual spinning begins; and the spinning is then usually done on mules, which in this country are

English

rarely used in the manufacture of worsted yarn. We shall discuss these machines when we come to woolens. According to the most common procedure in this country, the roving box not only draws, but imparts a certain amount of twist to the yarn. This is done by winding the yarn from horizontal spools on to vertical spindles. These spindles are set on long frames, similar to spinning frames, one frame containing about 200 spindles. The yarn is guided on the bobbin by an arm, known as the flyer, which draws the bobbin around after it.

Spinning

There is very little difference between this last drawing operation and the actual spinning which immediately succeeds it. In both cases the yarn is unwound from horizontal spools placed at the top of the frame through the inevitable two rollers going at different speeds, and guided on to the revolving spindle. Since the spindle revolves vertically the yarn is twisted. The amount of twist is regulated, as is also the amount of tension, and these two factors, together with the quality of the material, determine the quality of the yarn. Worsted yarn is graded accord-

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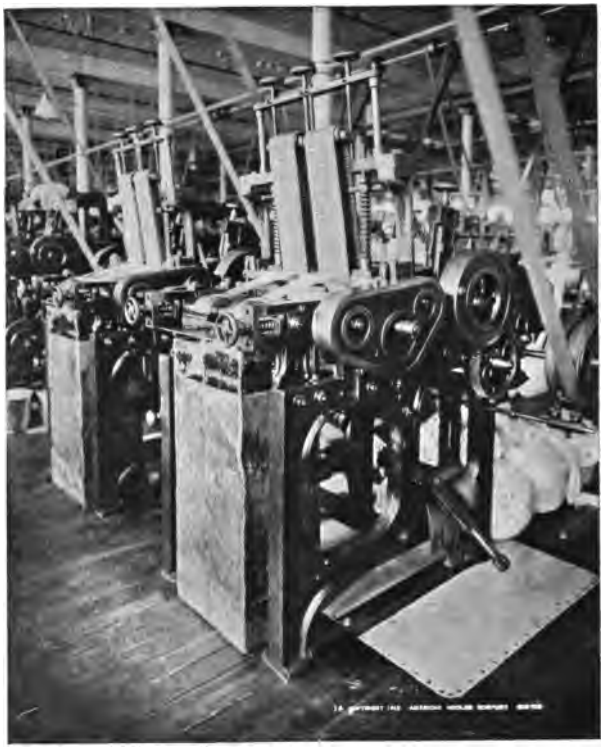

Drawing

ing to the number of counts, which, as we have seen, is the number of hanks of 560 yards that make a pound avoirdupois.

Roughly speaking, there are three modern methods of spinning, namely, the flyer, cap, and ring frames. All of them are derived from Arkwright's original water throstle, and, if we want to go further back, from the old-fashioned spinning wheel. To describe these machines in detail would be of little benefit to one who has not seen them, and to one familiar with mill machinery (should such a one by evil chance see this paper) it would be nothing if not ridiculous. The chief difference between the three types lies in the method of driving the spindle and guiding the yarn on to the bobbin. The flyer arm we have described briefly above. In the cap system, the bobbin is moved up and down in a fixed metal cap, something like the front end of a two-inch shell-cas-

Flyer

Cap

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ing, and this method of guiding the yarn has the advantage that, because of its lower vibration, the spindles may be driven faster. It also causes considerably more friction on the yarn. For worsted spinning it is probably the most commonly employed. Ring spinning is very similar (to the layman) except that the spindle revolves in a metal sleeve, and that the yarn is guided by a metal ring with a traveller, instead of by the end of the cap.

Ring

What follows now is merely an auxiliary process of spinning. The yarn has been completed, but it is rarely used for weaving, as it comes off the spindle. Several strands are usually twisted together, both to make it stronger and to give various effects of body and color. The number of strands in a yarn are designated as plys. Yarn consisting of two strands is called two-ply, three strands are three-ply, and so on. Yarns of two or more colors, or yarns of varying counts, are frequently twisted together. It is possible also to twist worsted and cotton yarns.

Twisting

Twisting is done in a manner similar to spinning. A worsted spinning mill usually has about a third as many twisting spindles as spinning spindles, but it is important to remember that when speaking of a mill's

Spindlage

Reducing

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capacity in terms of spindles, it is only the spinning spindles that are counted.

Winding or Skeining

After the twisting is completed the finished yarn is wound on small spools, known as cheesers, to be weighed. Next it is wound on large spools in such a way that the large spool holds the contents of from ten to twenty cheesers, each wound in an adjacent space at the same time. Some of the yarn is shipped to weaving mills on these large spools; and some of it is taken off them and skeined.

Waste

We are now ready to weave the cloth, but there are a considerable number of very interesting details which we have been forced to omit. All the processes we have discussed produce a certain amount of waste material. The combing waste, known as noils, is the largest by-product of the worsted industry, but there is also a considerable amount of yarn waste produced in the various drawing and spinning operations. Practically all of this material finds its way back, in one form or another, into the woolen industry. The subject of reclaiming waste is in itself so comprehensive that we can do no more than touch upon it here.

Cap spinning

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CHAPTER X

Dyeing

Wool and Piece and Double Dyeing

Some yarns are dyed after they have been spun. In most cases, however, woolen yarns receive their color after the wool is scoured and before it goes into the carding machine. In worsted manufacture the common procedure is to dye the top after it has been combed. In this way a uniform color is obtained, whereas it is exceedingly difficult to obtain the same color from two vats in piece-dyeing. Some materials are both wool and piece-dyed, the second dye being given to the cloth. This is done in cases where a peculiarly fast color is desired, or where the cloth contains separate materials such as wool and cotton.

CHAPTER XI

Worsted Weaving

The modern power loom represents one of the most remarkable achievements of industrial development. Into its perfection have gone the inventions and improvements of centuries, and volumes could, and have been written on the subject of modern weaving. Nevertheless, the old-fashioned hand-loom has not yet gone out of existence, and still finds its use in the development of new designs.

Warp and Weft

Weaving is, of course, the process whereby yarn is made into cloth, and its fundamental principle is that of the warp and weft structure. In its simplest form this means that a series of threads are stretched parallel to each other, thereby forming a warp. A second thread, called the weft, is then passed over the odd and under the even warp threads, and back again under the odd and over the even. In this way a cloth fabric will gradually be built up. In most cases the process has become considerably more complicated than this, but there are even now certain materials, such as calico, which retain the elementary weave. The actual weaving, that is, the passing of the shuttle carrying the weft thread over and under the warp threads, has now been reduced to an entirely automatic process, even with the most complicated designs, but the preparatory work still entails a large proportion of hand labor.

Elementary Weave

The work which has to be done before the loom can begin to operate is usually referred to as loom-mounting, and consists of five stages.

Warping

1. Warping is the arranging of the warp threads in the order necessary to produce the desired cloth. This was formerly, and still is to a great extent, done entirely by hand on a sort of rack known as the woof. In the larger mills, however, warping is now done either on a sectional warping machine or on the warping mill. Both these devices are only partly automatic, and require highly-skilled labor.

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2. The mechanical structure of woolen or worsted yarns necessitates the application of some glutinous substance to their surfaces before subjecting them to the weaving process. No matter how even the worsted yarn, a microscopic examination would show certain fibres protruding from the surface. Sizing has the effect of smoothing the surface of the yarn, and at the same time distributing more evenly the strain of weaving. The sizing machine is rather like the back-washer used in the

Sizing

Drawing in the warp threads

manufacturing of worsted yarn. The warp is run through the sizing bath and then compressed between rollers, after which it is dried by steam or fan.

3. Beaming is the term applied to winding the warp upon the beam of the loom. (The beam is the roller from which the warp threads are unwound as the weaving progresses.) In order to keep the threads in their proper position an instrument known as a raddle is employed, and the raddling process is one which requires considerable care.

Beaming

4. The next step, healding, can only be understood if we anticipate for the moment and consider the structure of the loom. It is necessary that the warp threads be lifted in sections in order that the shuttle may

Healding

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pass under some and over others. From the original weave of lifting alternate threads, a great many complicated designs have been evolved, which necessitate the lifting of the warp threads in many small series. In the elementary weave where there are only two groups, this work is done by heald-wires which raise the odd and depress the even threads, thus forming a V, known as the shed, through which the shuttle may pass. As the design becomes more intricate the healding process be-

Weaving

comes more complicated, and the number of heald shafts increases. Each wire has a hole in the middle through which its thread is passed, and the proper threading of these wires is known as healding.

Sleying

5. Sleying, or reeding, is the final preparatory process, and has the object of keeping the warp threads the proper distance apart during weaving. The sley is really nothing more than a fine comb with a strip

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across the ends of the teeth. The warp threads are passed between the wires (reeds) of the sley and are so compelled to keep their proper position.

The sley is attached to the batten, or fly, and performs the additional function of driving home each weft thread after the shuttle has passed.

Sleying is closely akin to healding, and both operations require great skill and care.

We have gone into these preliminary processes at some length, first, because they are extremely important, and second, because in this manner we are able to obtain perhaps a clearer picture of the loom than if we attempted to describe this highly complicated piece of mechanism in detail. Once these processes have been completed the remainder is almost entirely automatic. The shuttle flies back and forth without aid. The proper warp threads are raised and lowered to let it pass, and after each traverse, or pick, the batten automatically drives home the weft thread, into the growing stretch of cloth that is winding itself up on to the beam at one end, while the beam at the other end delivers the parallel warp threads. The motions are so many and so swift that the eye fails to catch more than a small fraction of them. The average worsted loom makes about 100 picks per minute, and a calico loom runs almost twice as fast. Yet the breaking of a single thread will bring the loom to a standstill.

The Power Loom

CHAPTER XII

Worsted Finishing

While, as we shall see, finishing in the woolen industry is a very important stage of manufacture, worsted materials are practically unchanged after they come out of the loom. There is sometimes a certain amount of fulling and raising and cropping, but the net result does not in any way alter the cloth, except perhaps to impart a little smoother finish. We shall discuss finishing in a little more detail when we come to the last stage of woolen manufacture.

Our worsted cloth is now finished, and we have traced its origin, somewhat sketchily, from the back of the sheep up to the point where it takes only a tailor to put it on the back of a man.

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PART THREE

WOOLEN MANUFACTURE

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Woolen card. Feed end

Woolen card. Condenser end

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CHAPTER XIII

The Manufacture of Woolen Yarn

We have taken the worsted industry first, not because it is necessarily any more important than woolen manufacture, but because its processes are more complicated, and therefore, if we have gained a certain amount of familiarity with them, we are able to take up the sister industry in a more abbreviated manner. Although, at the present time, the demand for worsted materials is a great deal heavier than the demand for woolens, the woolen industry is by far the older of the two, and may rightfully claim that the worsted branch is really an off-shoot of its tree. Moreover, while broadcloth and similar materials no longer enjoy their erstwhile popularity, there is still a tremendous demand for other products of the woolen industry such as blankets, flannels, overcoatings, etc. And we must bear in mind that most of the cheaper clothing materials are woolens.

Raw Material

In the sorting of wool we saw that the shorter staples were classed as clothing wools. To these must be added the noils from worsted combing, yarn waste, and wool reclaimed from off-sorts, as well as wool extract made from rags, before we have the raw material for the woolen industry.

Scouring

Whereas we found that combing wool had to be left in the grease until it could be carded immediately after scouring, the maker of woolen yarn will buy wool that has been scoured months before. Most of the wool that is scoured by or near the growers finds its way into the woolen industry for this reason. The scouring given to clothing wool varies only in that it is more violent than that given to combing wool, and in that it is frequently augmented by carbonization to remove vegetable matter.

Blending

The first process after scouring is blending. When the desired mixture of various grades, kinds, and colors of wool, wool extract, or cotton has been effected, the resulting heterogeneous mass is put through the first of several carding processes.

Fibres not parallel as in Worsted

From now on the desire of the woolen yarn manufacturer is diametrically opposed to that of the worsted comber. He wants to open out the fibres, but he wants them to lie in all directions. He does not want uniformity. He wants just the opposite. His yarn must have a certain amount of strength, but it must have, first of all, felting properties, so that when the cloth is finished the various threads will merge and interlock. As might be expected, therefore, the carding process is very much more violent.

The blend is first put through a fearnought which might be described briefly as the most pitiless member of the card family. It is also known

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as a tenter-hook-willy, from the reversed position of its teeth. From this machine the wool goes through the card proper, which is similar to the worsted card except that the rollers go in opposite directions, instead of in the same directions. Here, again, the doffer lifts the wool off in a continuous filmy sheet and delivers it to the condenser. The sheet is not simply drawn through a funnel into a single thick sliver, but is forced between rollers into two leather rubbing aprons which by pressure and friction reduce it to a series of small soft flabby slivers, having just enough adhesiveness to permit of mule spinning.

Carding

Condenser

The fibres in these slivers may be of all lengths and degrees of fineness, and they lie in all directions.

There are now no elaborate drawing or combing processes. All that remains to be done before we have a weavable woolen yarn is a certain amount of twisting and attenuation. Both these results are obtained at once in the mule.

Mule Spinning

In a woolen mule the spools of sliver are placed in a fixed frame, and the sliver passes between a pair of rollers to the spindles. These stand, slightly inclined backwards, in a long row upon the movable carriage. At first the spindle tips are close to the rollers. The sliver is paid out,

Mule Spinning

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and at the same time the carriage bearing the revolving spindles retreats. During this time no yarn is wound on the bobbins, but the slivers are being twisted. Then the rollers cease to pay our sliver, the carriage moves out a little further, and the spindles rotate faster, so that the yarn is being twisted and stretched. When sufficient twist has been imparted the carriage moves back again and the spindles wind up the twisted yarn on to the bobbins. This, briefly, is the operation of the mule. There are a great many intricate devices in this machine which deserve attention, but which hardly fall within our scope. All that remains now is to wind the yarn on spools, or skein it, before it is ready for the weaver.

CHAPTER XIV

The Manufacture of Woolen Cloth

There are many differences between weaving worsteds and woolens, but for our purposes we may consider the process the same, as in a general way it is. Some cloths are woven with a cotton warp and a woolen yarn filling, the warp being carefully concealed. Woolen cloths are more frequently woven with a backing than worsteds. This means

Weaving

Burling and mending

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that either there is a double warp, a double weft, or both. The object of backing is usually to add strength and warmth to the material, and the lower side is therefore often woven of coarser yarn. In some cases, however, notably in travelling rugs, the backing may be just as elaborate as the face, and this necessitates a rather intricate mounting process.

Carpets

Carpet weaving is one of the large branches of the woolen industry, and for this purpose the coarsest and longest fibred wools (common, braid, and carpet wools) are usually employed. These wools readily lend themselves to the manufacture of a coarse thick yarn, which in turn produces a thick, durable material. The thickness of a carpet is known as the pile.

Finishing Important in Woolens

Whereas we saw that the worsted cloth was practically finished when it left the loom, this is not the case with woolens. Oftentimes it would tax an expert to identify the finished goods with the loose and altogether different material produced by the weaver. Some fine woolens, it is true, are scarcely altered more than worsteds, but in most cases the finishing operations are in this industry a major rather than a subsidiary stage of manufacture. The reader may have been puzzled at the divergent lines along which woolen and worsted yarns are manufactured, and at a loss to account for the reasons. The cause is precisely this, that the worsted manufacturer aims to produce a cloth that is completed when woven, while the woolen maker wants his loom to turn out a material that will readily adopt a great variety of finishes.

Burling

The first finishing operation, which applies also to worsteds, is the examination of the piece for imperfections and the removing of them by hand. The piece is then scoured to get rid of dirt, and, where the finish is complicated, this may be repeated several times.

Fulling

Fulling, the next and very important process, consists in passing the material through closed or partially enclosed boxes, in which the cloth is run through soap solutions and then forced through rollers. The result of fulling is to shrink the material and give more body to it. It is chiefly in order to be able to do this that the maker of woolens wants the fibres in his yarn to lie criss-cross, so that in the fulling mill their serrated edges will felt and interlock with each other. The amount of fulling done depends upon the shrinkage desired. It is possible to reduce the size of the cloth by half in this process. Some worsteds are slightly fulled, but in their case it simply serves to add a little body to the cloth, without in any way sacrificing the design of the weaving. Long before the invention of even the earliest textile machinery there were great numbers of water-driven fulling mills, in which the woolen cloth was pounded in fuller's earth by wooden hammers. In those days the cloth was felted into a stiff thick mass which would resist wear almost inde-

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finitely, but which would hardly adapt itself to modern stream-line tailoring.

The fulled piece is next made to revolve on a large drum set with teazle-heads. The object of this procedure is to open out the fibres, and the process is known as raising. In worsteds and fancy woolens, such as trouserings, raising is really nothing more than the brushing up of the loose fibres so that they may be cropped off, much as grass is cut on a lawn. This will of course have the effect of showing up the weave very plainly. In most woolens, however, the cloth is raised wet, and the teazle motion is more violent, so that the entire surface is covered with a thick nap of brushed up fibres which entirely conceal the weave. This is often very desirable where coarse backing threads are to be hidden, or where, for other reasons, a thick nap is desired, as for instance in rough

Raising

Fulling

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Cropping

overcoatings. There may be several raisings and croppings, between which the material is boiled and pressed, all depending on the character of the face that is desired. In some cloths the finishing processes are exceedingly complicated, particularly where a smooth finish such as doeskin is sought. The variety of finishes is infinite and new ones are constantly being invented, many of which are closely guarded trade secrets. In most cases pressing completes the process.

Pressing

We have now followed both the combing and the clothing wools through the process of manufacture into worsted and woolen yarns and cloths. Again, let us emphasize that the relative amount of space devoted here to the two industries is governed, not by their comparative importance, but by what appeared to be the most concise method of approach. Many details, which loom up as tremendous problems to the manufacturer, have been treated here with scant respect, and others have not even been mentioned, but, in a paper such as this, which seeks to give the outline of so much in so brief a space, it is essential not to lose sight of the whole picture through too close a contemplation of its component parts.

CHAPTER XV

Mohair and Alpaca

There are two materials upon which we have not touched at all, although they are generally included in wool manufacture. Mohair is the hair of the Angora goat, and has many characteristics of both hair and wool. These animals are native to Asia Minor, but are now extensively raised in other parts of the world, notably in Africa and in this country. The hair averages about four inches in length, although it frequently grows much longer, is very smooth and fine, has considerable tensile strength, low elasticity, and practically no felting property. It is used primarily in the manufacture of plush, such as is used in railroad carriages, and makes very durable material. It is also woven into Palm Beach cloth, or mixed with worsted or cotton yarns in such fabrics as automobile tops.

Mohair

Alpaca is a similar fibre, obtained from an animal native to Bolivia and Peru. The fibre is finer than mohair, and a little more like wool. It comes in three natural colors; white, brown, and black, all of which are found on the same fleece. Alpaca is both light and soft, and therefore lends itself admirably to the manufacture of thin linings.

Alpaca

CHAPTER XVI

Knitting and Felt Manufacture

Whereas most yarn is woven into cloth, there is also a second process, known as knitting, in which the individual threads are interlaced into a

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regular fabric without warp and weft structure. The work is performed on a sort of loom, called the stockinette frame, upon which the yarns are arranged in parallel order and uniform distances apart. The actual knitting closely resembles hand knitting, and is done entirely by automatic mechanism. A machine of this sort is capable of turning out a great length of material in a short time, and the fabric has the fine ribbed character seen in ordinary knitted goods. The article is soft, full, and elastic, but lacks the strength and firmness of woven fabrics. Stockinette cloths, sweaters, some underwear, and hosiery are products of the knitting machine, and the knitting mills are important consumers of noils and low-grade wools.

Stockinette Frame

Besides being made into yarn, and woven or knit into goods, wool is also compressed into felts of various kinds. Space unfortunately is lacking for the consideration of this subject here, although a considerable quantity of wool goes into felt manufacture.

Felt

Steaming

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Cropping

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PART FOUR
THE FINANCIAL ASPECT

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CHAPTER XVII

Bearing in mind the industrial structure we have just outlined, it might be well for us to glance briefly at its financial scaffolding. From the banker's point of view there are many features which are distinctive of the wool trade, and which exercise an important bearing upon the judgment of a credit risk.

Sheep Banks

To begin with the grower, we find here that in many instances the large raisers of sheep have built up their own banks. In Texas, for instance, there are a considerable number of banks whose chief business consists in financing the wool clips of their sections. On the other extreme we have the small grower of the East, who is frequently at the mercy of the local storekeeper. Where wool growing is practised on a large scale in this country the tendency is more and more to reduce the business to a scientifically standardized scale, in such a manner as is prevalent in Australia. The more this is done the more independent the grower becomes, and the easier it is for a bank to determine the strength of the individual risk. The sheep raiser has of course one primary asset, his flocks; and if he is compelled to borrow, the security behind his note rests upon his sheep. In making a loan to a sheep man a bank has to consider not only the market value of the animals, but the conditions under which they are being raised. Sheep are affected by droughts, for instance, and many flocks have been ravaged by predatory animals, or decimated by disease. Any one of these contingencies may at any moment destroy or depreciate the bank's collateral, and for this reason borrowing of this sort is confined very largely to banks situated in sheep-growing sections which specialize in this form of loan.

Sheep Risks

It would be of great interest to figure the average cost of production per pound of wool to the grower, but, with the varying conditions encountered in different parts of the country and with sundry breeds, an accurate estimate can hardly be arrived at. Even the cost of shearing is variously figured from ten to nearly thirty cents. Generally speaking, however, the grower needs very little financial assistance, because he is able to sell his entire clip for cash. The buyers representing merchants —or in a few cases, mills—are prepared to pay cash for their wool, and in some cases where they feel sure of a rising market, often go so far as to buy the wool on the sheep's back before it is shorn. Provided the grower knows something about wool, and the existing demand, there is no reason why, from the proceeds of one clip, he should not be able to meet his costs up to the time of the next shearing.

Grower's Cost

The Merchant

The merchant is up against a very different proposition. As we have seen, he buys for cash, and not only sells on credit, but carries a large proportion of what he buys for several months, before he can dispose of it. There are so many kinds of wool merchants that it is almost impos-

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sible to make any general observations. One merchant, for example, may specialize entirely in domestic wools; in that case he would do all his buying in the spring months and would gradually dispose of his material, having first graded it, during the remainder of the year. Another house might do the bulk of its business in South American wools, which would mean a fall purchasing season. Still another would handle both domestic and South American, and a fourth might import from all parts of the world, so that buying and selling would be going on continuously and at the same time throughout the year. The credit requirements of the first two houses would be an easier demand upon the bank than those of the latter, but in all cases the judging of the risk involves certain primary considerations, each of which really necessitates the close study of the individual case.

Futures

A wool merchant's business is largely based on his estimate of the future. Were it not for the fact that he assumes a risk which neither the grower nor, in most cases, the manufacturer is able to take, he could not maintain his position as the middleman. The merchant's buyer must, as we have seen, be able to judge the amount of shrinkage within a very small fraction, he must know the demand for each quality of wool so that he may be sure not to pay more than he can sell for, and, what is more, he must be able to forecast the future with a certain amount of accuracy in order to make his profit. Furthermore, the merchant must be constantly on his guard against doing more business than his capital warrants, while at the same time, unless he makes every dollar work, his business will in normal times fail to show him a profit. All these things depend almost entirely upon the individual's character and ability, and as a matter of fact loans made by Boston banks to the big wool merchants are based far more upon the moral risk than in most other lines. Many of the large dealers operate as partnerships, and here again is a factor which makes for individual judgments rather than for any fixed standard. The largest houses borrow at times in the open market, but a great part of the wool financing is done by the banks in the wool centers, such as Boston. Some of these loans are made on straight notes, but an ever-increasing quantity are on the acceptance basis. Practically all the foreign wool imported through Boston is financed by letters of credit, the raw wool being released in many cases under trust receipt and sold for manufacture. Domestic shipments are also being handled more on acceptance agreements than formerly, although the old-fashioned draft shipment is still generally in vogue.

Credit Risks

Wool Financing

There are a few tangible elements which make for a good or bad risk, chief among which is the matter of collections. The mills to which a merchant sells are often a very good criterion of his business methods and trade standing, and the amount of slow accounts is frequently a very useful barometer.

Collection

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Some wool dealers have become considerably more than middlemen, and have gone quite extensively into the first stages of manufacture. This is particularly true of some of the large Boston houses which of recent years have established top manufacturing departments, and which therefore sell a large proportion of their goods not as raw wool but as tops and noil. *Merchant Manufacturers*

Although the dealers do the bulk of the commission work in consignment sales, there are a great number of brokers whose function is primarily the buying and selling for account of others. These houses usually operate with a limited capital, and are not extensive seekers of credit. The important factor in judging a risk of this nature is to make sure that such a house is confining its activities to brokerage and is not speculating on its own account. *Brokers*

So far as the manufacturers, or mills of various sorts, are concerned, there is nothing essentially different about these risks from others in similar lines. While the moral risk is important, there is usually plenty of information available to the banker, in regard to the capitalization, earnings, gross business, costs, assets, and liabilities. There is one striking difference about the paper of woolen and worsted mills as against cotton mill notes which appear in the open market; cotton mill paper, except in the case of the strongest mills, usually bears the endorsement of the commission house which sells the mill's products, but this is not the case with woolen and worsted mill paper as a rule. The reason for this is that a large number of the wool manufacturing establishments sell direct to wholesalers and jobbers, and have no close affiliation with a selling-house. *Mills*

Trade terms vary a good deal. Raw wool is almost invariably sold for cash by the grower. Dealers make various terms to mills, the most usual being 1% ten days, sixty days net. The terms on which mills sell to jobbers also have a wide range; some sell thirty days net, some 10% thirty days, others 7% four months. *Trade Terms*

CHAPTER XVIII

Industrial Organization and Costs

While any analysis of costs, even were it made by an expert, would undoubtedly occasion considerable argument and criticism, it might be well to cast a passing glance at the distribution of processes and costs in wool manufacture.

The costs of growing and shearing the wool is, as we have seen, borne by the grower. What the cost is we cannot even estimate, because of the wide variation of geographical and temporary conditions. Whatever the amount, the price paid for raw wool by the merchant *Cost Sketch*

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covers it, as well as the grower's profit. Let us call it 80 cents per pound in the grease.

The merchant grades the wool and sells it to the woolen manufacturer at, let us say, 90 cents per pound, which covers his cost and profit. Assuming that the manufacturer does his own scouring, he will then find, if the wool shrinks 60%, that he has paid $2.25 per pound of scoured wool, to which must be added about seven cents to cover the cost of scouring.

The cost of carding and spinning depends upon the size of the yarn and varies from about $.12 to about $.45 per pound of yarn.

Weaving, including all costs of labor and overhead, will then cost from $.08 to $.37 cents per yard depending upon the number of picks the loom makes for each inch of fabric produced.

Assuming that it takes a pound of yarn to make a yard of cloth, and that it takes a pound and a fraction of scoured wool to make a pound of yarn, we then have:

Wool	$2.25
Conversion to yarn	.30
Net waste	.20
Dyeing	.15
Weaving	.25
Finish	
	$3.15

If we then add $.26 a yard arbitrarily as the cost of finishing, packing, etc., we find that we have an all woolen cloth at $3.41 per yard. Selling expense and profits of mill and jobber would bring it up to about $4.70. A suit made out of this cloth would probably cost in the neighborhood of $65.00 ready made, of which only about 24% would be for the cloth. Of this 24% nearly 50% would be for raw material. It is easy to see from this cost sketch that the high price of a suit of clothes is only slightly brought about by scarcity of raw material and high cost of mill operation, and that the chief rise has come in the making of the cloth into clothes.

Greater Subdivision in Worsted Industry

There is a tendency to far greater industrial subdivision in the worsted industry than in woolens. As a general rule the maker of woolens buys his wool scoured, or has it scoured on commission. He then makes his own woolen yarn either out of wool or shoddy, or a mixture of both, or both and cotton. Usually the only thing he buys outside of his raw material is cotton yarn, if he uses this in some of his fabrics.

In the worsted industry there are generally a greater number of separate units. The top-maker, frequently the merchant, scours the wool and cards and combs it. He then sells his top to the spinner of

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worsted yarn. The spinner is usually not the ultimate manufacturer, but is either an independent maker of yarn, or else spins on commission for the manufacturer. Some of the very large worsted manufacturers begin with the raw material and carry it through to the finished product, but it can be readily seen that this procedure involves a very large plant. In most cases the manufacturer buys his yarn as he needs it. The cost analysis is therefore more complicated and contains a greater number of profits or commissions, and this, together with the higher cost of raw material and of manufacture, makes a worsted cloth a little more expensive than the corresponding grade of woolen. However, even if it costs one-third more, this will only mean a matter of about four dollars in the cost of the suit. This is one of the reasons for the great demand for worsted clothing.

CHAPTER XIX

Demand and Supply

Sheep raising is, as we have seen, chiefly carried on on the borderlines of civilization. As civilized life encroaches upon the pasture lands the flocks are driven gradually further and further into hitherto uninhabitated regions. The population of the world is steadily increasing, and the available grazing areas are constantly being reduced as the world becomes more thickly populated. Also, as the population increases, the demand for clothing and food increases, so that, on the face of it, it would seem that the production of wool would decrease while the demand grew constantly larger. In a measure this is true; but there are several factors which tend to arrest this Malthusian spectre. In the first place, there are still vast areas of desert land which can be reclaimed for grazing purposes. In the second place the growing of wool in most countries is as yet practiced on a very crude and consequently uneconomical scale. And, finally, the use of shoddy and wool regained from rags, has only begun to be developed. Nor is it true that sheep must necessarily be raised in uncultivated regions; England, with her closely settled soil, supports about three-fifths as many sheep as the United States, on an area of only 121,377 square miles, as against the 3,026,789 square miles in this country.

Supply Decreasing?

Demand Increasing?

According to the latest available figures there are about 580 million sheep in the world of which North America has 57, South America 72, Europe 182, Asia 97, Africa 60, and Australasia 112. In 1918 there were estimated to be 592 million, and in 1917, 605 million. The high point in the United States was reached in 1884, when there were estimated to be 51 million sheep, as against slightly under 50 millions now.

Sheep

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Wool

These figures are, of course, difficult to obtain, and even more so are those relating to wool production. The world's total output in 1919 is estimated at two billion, eight hundred and ninety-four million pounds. North America 336 million, South America 485, Europe 772, Asia 326, Africa 150, Australasia 825. Whether this is an actual increase or decrease cannot as yet be determined on account of the War.

Although the effect of the War is not definitely known as yet so far as the number of sheep and the production of wool are concerned, its influence is very plainly discernible in the price scales. Just as the Civil War brought about an enormous rise in wool prices, so also this last struggle left its mark. Due to the complete disruption of many industries, the stimulated demand for clothing, and the general

WOOL PRODUCT OF THE UNITED STATES

Year	Pounds	Year	Pounds
1897	259,153,251	1908	311,138,321
1898	266,720,684	1909	328,110,749
1899	272,191,330	1910	321,362,750
1900	288,636,621	1911	318,547,900
1901	302,502,382	1912	304,043,400
1902	316,341,032	1913	296,175,300
1903	287,450,000	1914	290,192,000
1904	291,783,032	1915	288,777,000
1905	295,488,438	1916	288,498,600
1906	298,715,130	1917	285,573,000
1907	298,294,750	1918	299,921,000

IMPORTS OF WOOL INTO THE UNITED STATES

Year	Pounds	Year	Pounds
1896	230,911,473	1907	203,847,545
1897	350,852,026	1908	125,980,524
1898	132,795,302	1909	266,409,304
1899	76,736,209	1910	263,928,232
1900	155,918,455	1911	137,647,641
1901	103,583,505	1912	193,400,713
1902	166,576,966	1913	195,293,255
1903	177,137,796	1914	247,648,869
1904	173,742,834	1915	308,083,429
1905	249,135,746	1916	534,828,022
1906	201,688,668	1917	372,372,218
		1918	422,414,985

Present Prices

inflation of prices consequent upon war, the last three years have shown remarkable fluctuations in the prices of various grades of wool.

If we consider for a moment that it makes a difference of only about four dollars in the price of a suit of clothes, whether it is made of the finest or the coarsest wool, it is obvious why, when general inflation has carried the price of a suit from forty to eighty dollars, even

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the common laborer will want the softer and finer-finished goods made from half-blood wool, rather than the coarse material manufactured out of low quarterbloods. Add to this the fact that Germany, which before the War was one of the heaviest consumers of coarse wools, has been rendered incapable of purchasing raw material, and it needs no further explanation to account for the high price commanded by fine wools and the cheapness of the coarser grades. A study of the accompanying price table will show the relative position of the prices of today.

The Future?

So far as the future is concerned, there are so many factors which must be taken into account that it is impossible to hazard even a guess as to what the trend of prices will be. It is reasonably certain that the gap between the present prices of fine and coarse wools will narrow to more normal proportions. Whether the coarse wools will appreciate, or the fine wools depreciate, or both, is the question that every wool man is at the present trying to solve. It looks as if it would take several years before the machine famine can be met. At the present time second hand textile machinery is worth more than new machines a few years ago, and mills are willing to pay fabulous prices in order to be able to increase their output. As long as this condition prevails, the goods market can hardly fail to maintain its present high level, unless Europe can break the price by underselling the American manufacturer in his own market or unless the demand falls off to a very large extent. Many authorities believe, on the other hand, that an era of falling prices has set in and that it will affect clothing as rapidly as other commodities, so that the whole question of future values and prices presents a study beyond the scope of this pamphlet. For our purposes it is well to bear in mind only the fact that wool, as bank collateral express or implied, is every bit as much subject to fluctuation as stock exchange securities. We might compare the coarse wools to the railroad stocks; they certainly look low, they ought to go up, and they may go down. The fine wools we might then liken to the industrial shares; they look high, they ought to go down, and they may go up. In the last analysis we know nothing whatsoever about it.* The best a bank can do is to decide which wool merchant is able and honest, and keep a fatherly eye upon his borrowings to prevent his getting over-extended. To do this, however, is not merely a matter of forming a personal estimate of the man; it necessitates a careful study of his business as well as of his character. Whether he is right or wrong about the future, the future alone knows. Whether he has been right or wrong about past futures is a matter of record to the careful observer.

Sound Judgment Based on the Past

Note for 3rd edition.

*As a matter of fact the gap did narrow, as every one who follows the wool market knows. Between April, 1920, when this pamphlet was written, and the

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present time, April, 1921, fine wools have depreciated fully 60% while the lower grades have lost only a comparatively small proportion of their value, so that at the present time the difference between the finest wools and common braid is only about 30c on a grease basis, whereas a year ago the spread amounted to about $1.00. 3/8 blood domestic wool, to take a rough barometer, is now selling at just about the 27c level of 1914.

PRICES OF DOMESTIC WOOLS. WASHED OHIO FLEECES

(*Cents per Boston pound*)

		Fine	Medium	Coarse
July 1st.	1824	.55	.40	.30
	1834	.60	.50	.40
	1844	.45	.37	.32
	1854	.45	.37	.30
	1860	.55	.50	.40
	1864	1.00	1.00	.90
	1865	.75	.73	.65
	1870	.46	.45	.43
	1875	.52	.49	.46
	1880	.46	.48	.42
	1885	.32	.31	.28
	1890	.33	.37	.29
	1895	.18	.21	.19
	1900	.28	.31	.27
	1905	.36	.39	.36
	1907	.34	.36	.35

Since about 1907 very little washed wool has come to this market. The following prices are quoted on an unwashed basis for the same wools, and therefore represent about 66% of what washed prices would be.

		Delaine	⅜	¼
	1913	.225	.235	.235
	1914	.275	.275	.265
	1915	.295	.365	.365
	1916	.345	.410	.400
	1917	.735	.745	.735
	1918	.750	.780	.770
	1919	.800	.650	.650
Jan. 1.	1920	.950	.680	.650

While it is not feasible to give here a price scale of all varieties of wools the above tabulation of Ohio fleeces will give the reader some idea of the general trend.

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